HR-260 Optimization of Soil Stabilization with Type C Fly Ash

Key Words: Fly ash, Calcium aluminates, Cements, Stabilization

ABSTRACT

Previous Iowa DOT sponsored research has shown that some Class C fly ashes are cementitious (because calcium is combined as calcium aluminates) while other Class C ashes containing similar amounts of elemental calcium are not (1). Fly ashes from modern power plants in Iowa contain significant amounts of calcium in their glassy phases, regardless of their cementitious properties. The present research was based on these findings and on the hypothesis that: attack of the amorphous phase of high calcium fly ash could be initiated with trace additives, thus making calcium available for formation of useful calcium-silicate cements.

Phase 1 research was devoted to finding potential additives through a screening process; the likely chemicals were tested with fly ashes representative of the cementitious and non-cementitious ashes available in the state. Ammonium phosphate, a fertilizer, was found to produce 3,600 psi cement with cementitious Neal #4 fly ash; this strength is roughly equivalent to that of portland cement, but at about one-third the cost. Neal #2 fly ash, a slightly cementitious, Class C, was found to respond best with ammonium nitrate; through the additive, a near-zero strength material was transformed into 1,200 psi cement.

The second research phase was directed to optimizing trace additive concentrations, defining the behavior of the resulting cements, evaluating more comprehensively the fly ashes available in Iowa, and explaining the cement formation mechanisms of the most promising trace additives. X ray diffraction data demonstrate that both amorphous and crystalline hydrates of chemically enhanced fly ash, differ from those of unaltered fly ash hydrates. Calcium -aluminum silicate hydrates were formed, rather than the expected (and hypothesized) calcium silicate hydrates. These new reaction products explain the observed strength enhancement.

The final phase concentrated on laboratory application of the chemically enhanced fly ash cements to road base stabilization. Emphasis was placed on use of marginal aggregates, such as limestone crusher fines and unprocessed blow sand. The nature of the chemically modified fly ash cements led to an evaluation of fine grained soil stabilization where a wide range of materials, defined by plasticity index, could be stabilized. Parameters used for evaluation included strength, compaction requirements, set time, and frost resistance.